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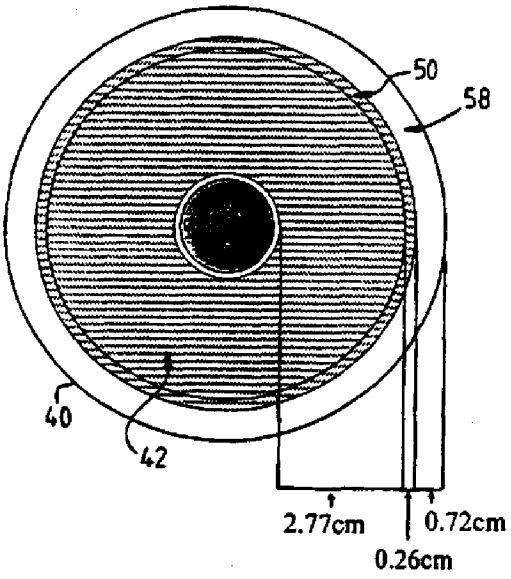
(54) Abstract Title
Optical storage disc storing compressed and uncompressed data

(57) An optical storage disc, for example a Compact Disc (CD) or Digital Video Disc (DVD), has stored thereon a first set of data comprising audio data for playback by an optical storage disc player system, and a second set of data comprising a compressed version of the same audio data. The compressed version can thus be downloaded directly from the disc to another storage medium, for example a solid state audio player system, which has the ability to decompress the data. The second set of data may further comprise interactive multimedia data and may also be encrypted. Details of the compression and encryption algorithms may be stored on the disc. The same CD (or DVD) can also be used for normal playback of the audio data in a conventional CD or DVD player.

Fig. 6



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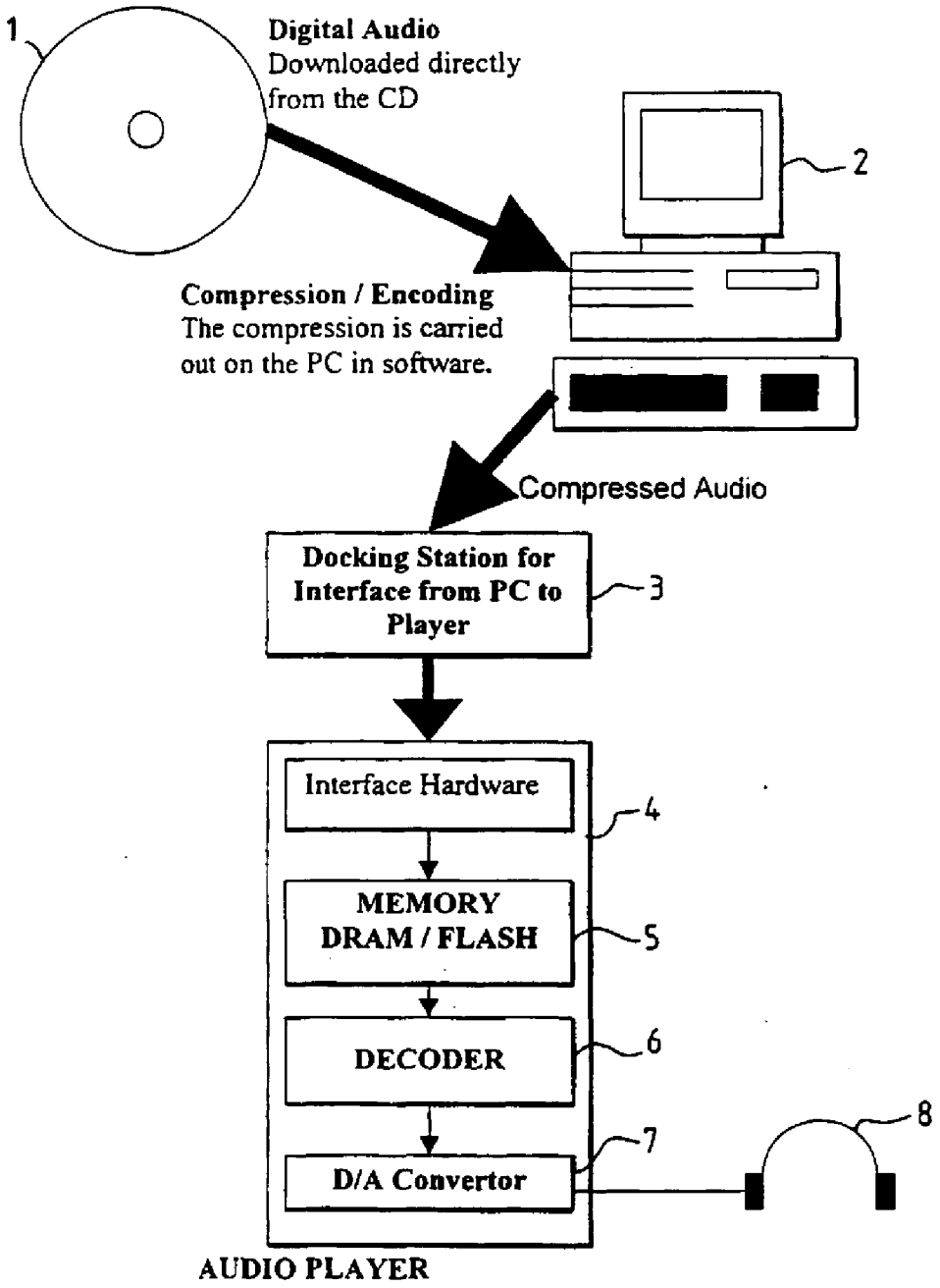

Fig. 1

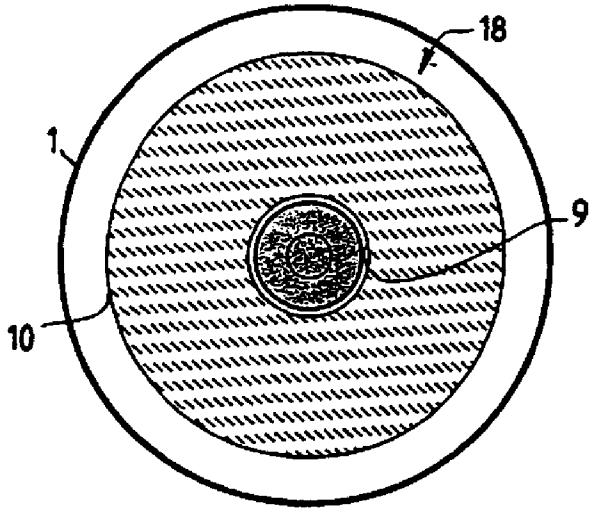

Fig. 2

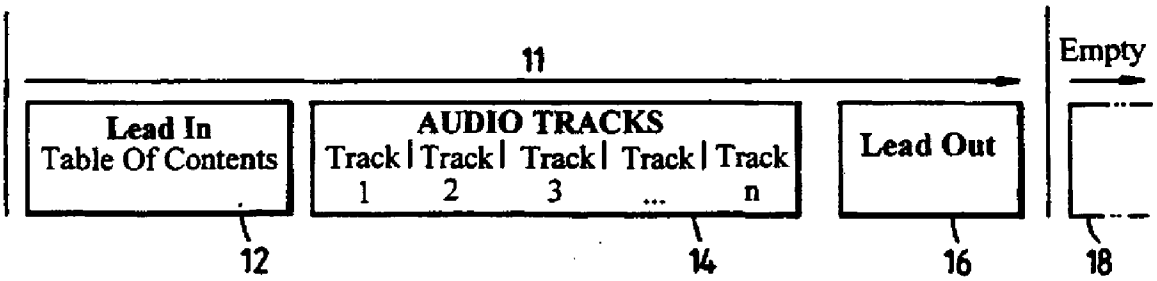

Fig. 3

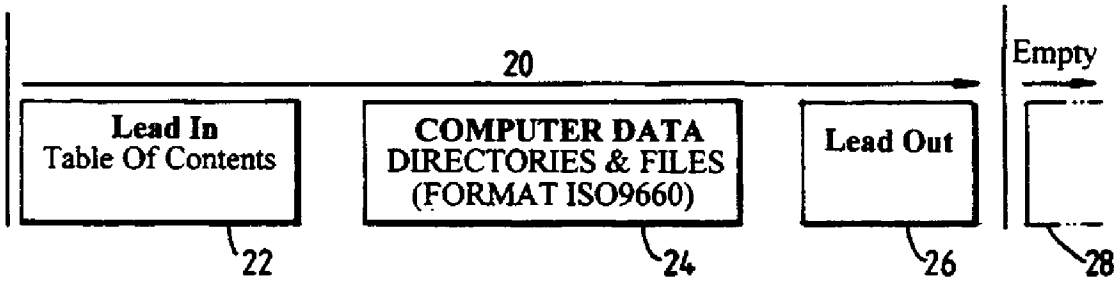

Fig. 4

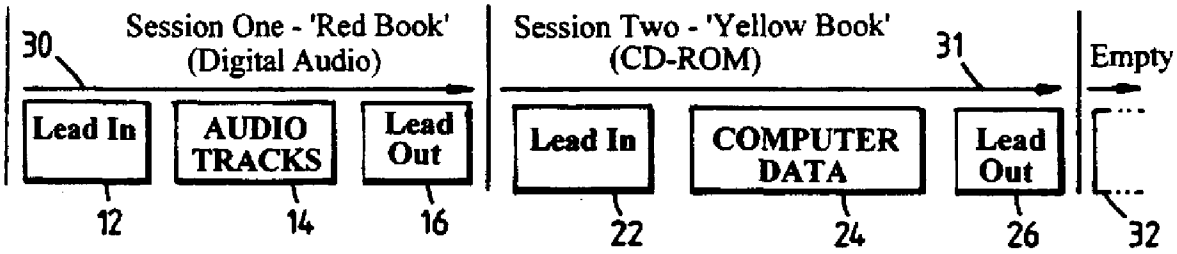

Fig. 5

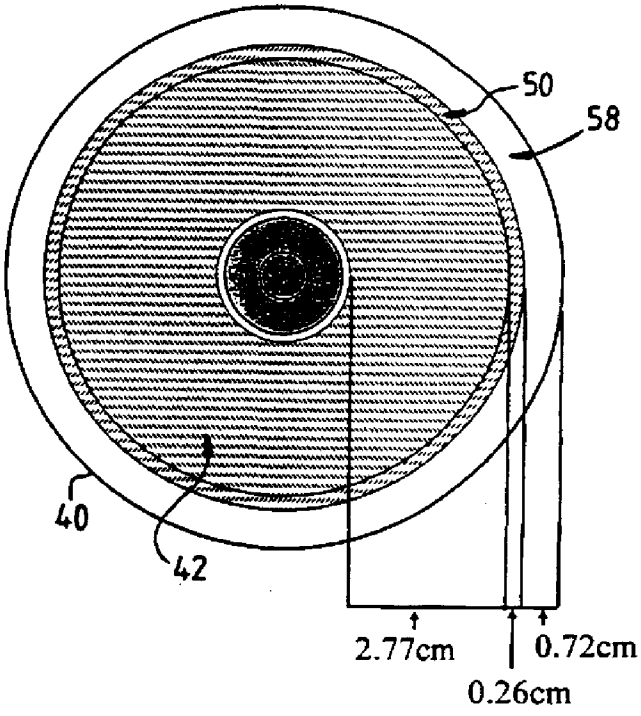

Fig. 6

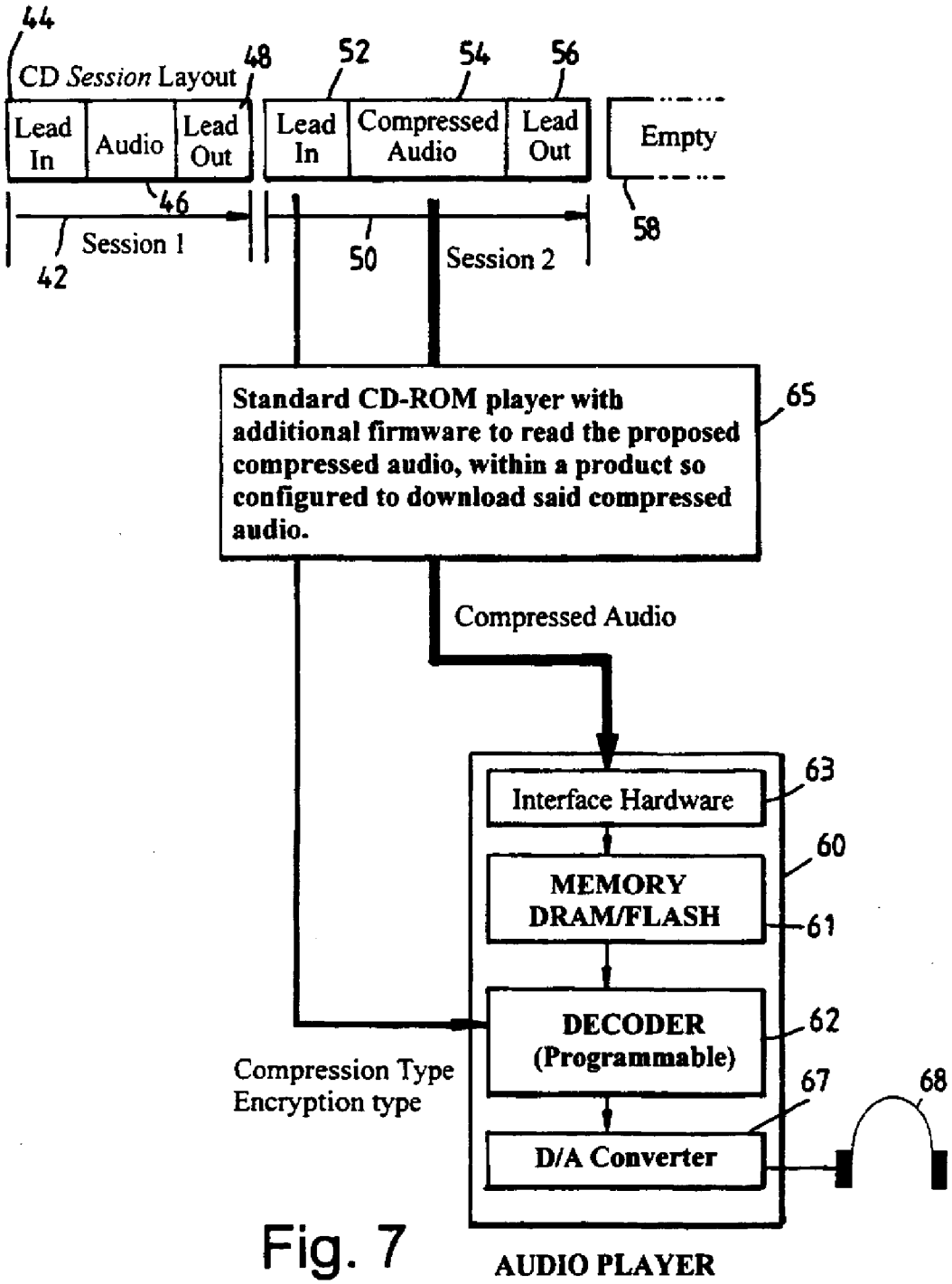

Fig. 7

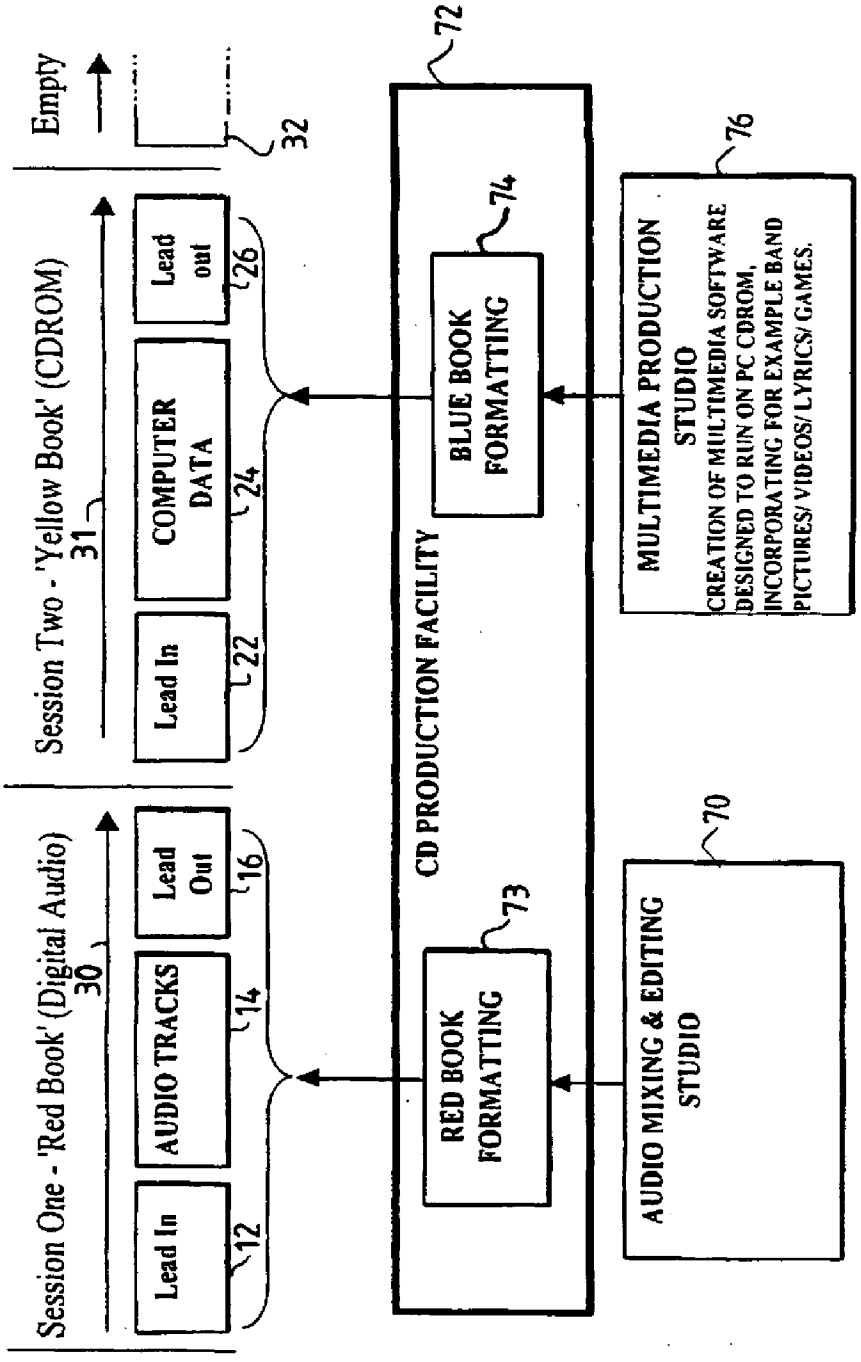

Fig. 8

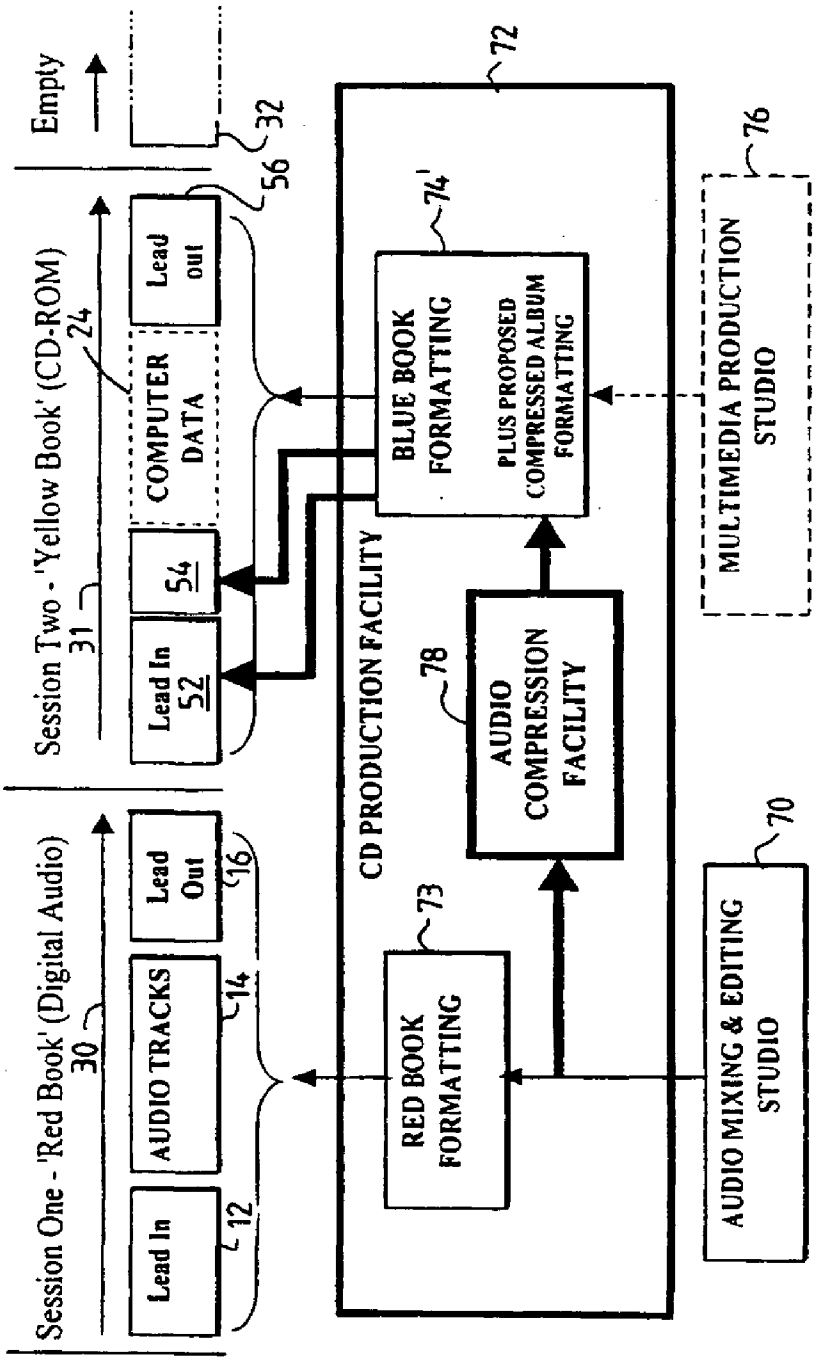

Fig. 9

OPTICAL STORAGE DISC

The present invention relates to the storage of compressed audio data and the transfer of compressed audio data from one data storage medium to another. More specifically, though not exclusively, the invention relates to a new Compact Disc (CD) product which enables audio data to be downloaded at high speed to a solid state storage medium.

Solid state audio player systems are currently available which playback audio data (e.g. music or spoken word) stored as digital data on solid state memory e.g. FLASH memory. Compact Discs (CDs) are used to store audio data for direct playback on a CD player. To store an average length CD album on solid state memory would require approximately 500MB of memory. It is not practical to provide this amount of, for example, FLASH memory in a solid state audio player system since current costs of FLASH memory would be prohibitive.

For this reason, current methods of using solid state memory to store audio involve the use of audio compression techniques. Currently employed methods of compression for transfer of CD audio onto solid state memory devices use software compression algorithms which are run on a PC. Here

the audio data is read directly from the CD and compressed using a compression algorithm, such as MPEG, in the PC, where the data can be stored in a file with a compression factor ranging from 4:1 to 24:1. Once the compression is carried out, the file is then transferred to the target solid state memory device, which could for example, be a removable solid state memory card (which may be inserted in another PC or audio player system), or a solid state audio player system designed to interface with the PC, for example via a docking station. In order to decode the data for audible listening, decompression is required. Decompression is normally carried out in real-time, in the player system, as the compressed data is read from the storage medium. Fig. 1 illustrates such a known system in which audio data is downloaded from a CD 1 to a PC 2 which carries out the necessary data compression using compression software loaded into the PC for this purpose. The compressed audio is downloaded to a solid state audio player device 4, via a docking station 3. The downloaded data is stored in DRAM or FLASH memory 5 in the player device which also incorporates decoder means 6 for decompressing the audio data, and a D/A convertor 7 for converting the digital data to analogue form for playback to the user, via headphones 8.

Disadvantages of the above-described operations are that a PC, or other similar processor, is required to compress the audio data, and the actual compression of the audio data can be extremely time consuming for the user. It is an object of the present invention to avoid or minimize one or more of the foregoing disadvantages.

According to the present invention we provide an optical storage disc, for example a Compact Disc (CD) or Digital Video Disc (DVD), having stored thereon a first set of data comprising audio data for playback by an optical storage disc player system, and a second set of data comprising a compressed version of said audio data.

The invention thus has the advantage of enabling the compressed version of the audio data to be downloaded directly from the disc to another storage medium, for example downloaded directly to solid state memory, for example to a solid state audio player system which has the ability to decompress the data. The same CD (or DVD) can also be used for normal playback of the audio data in a conventional CD or DVD player.

The audio data in said first set of data preferably comprises an album of music tracks, whereby said second set of data comprises a compressed version of the whole album.

The optical storage disc may comprise a first session consisting of a first lead in, said first set of data and a first lead out, and a second session consisting of a second lead in, said second set of data, and a second lead out. The disc may further include additional data, such as computer-executable interactive multimedia data.

Alternatively, the optical storage disc may be a single session disc where said first set of data is stored thereon as a number of audio tracks in a single session and said second set of data is stored as an additional track in the session, the session further including a lead in and a lead out.

Preferably details of the compression algorithm used to compress the audio data are also stored on the optical storage disc, preferably in a lead in of a session which contains said second set of data. Audio player systems which are to be used for playback of the compressed data would be provided with means for reading and recognising these stored details of the

compression algorithm, and with decoder means programmed to decompress the compressed data using these recognised details.

The compressed data of the second set of data stored in the optical storage disc may also be encrypted. In this case a lead in of a session of the disc which contains the encrypted data preferably includes details of the encryption algorithm used to encrypt the data. The audio player system(s) to be used to playback the compressed, encrypted audio downloaded from the disc would, in this case, further be provided with means for recognising the encryption details stored in said lead in, and with decryptor means programmed to decrypt the data using these encryption details.

According to another aspect of the invention we provide a method of storing audio data on an optical storage disc, for example a CD or DVD, comprising storing on the disc a first set of data comprising audio data for playback in an optical storage disc player system, for example a CD or DVD player, and further storing on the disc a second set of data comprising a compressed version of said audio data.

Preferred embodiments of the invention will now be described by way of example only and with reference to the following drawings in which:

Fig. 1 is a schematic diagram illustrating a prior art process for storing compressed audio onto solid state memory;

Fig. 2 is a schematic plan view of a conventional CD;

Fig. 3 is a block diagram illustrating schematically the content of a conventional single session CD;

Fig. 4 is a block diagram illustrating schematically the content of a conventional CD-ROM;

Fig. 5 is a block diagram illustrating schematically the content of a conventional multi-session ("Blue Book") CD;

Fig. 6 is a schematic plan view of a new CD according to the invention;

Fig. 7 is a schematic diagram illustrating high speed download of audio data using a CD according to Fig.6;

Fig. 8 is a block diagram illustrating schematically the production processes used to produce a "Blue Book" type CD; and

Fig. 9 is a block diagram illustrating schematically the production processes used to produce the CD of Fig. 6 according to one embodiment of the invention.

As illustrated by Fig. 2, digital data information on a conventional CD 1 is stored on a spiral groove 10, in the form of pits and bumps which can be read back by a laser apparatus (of a CD player or CD-ROM drive in a PC) and subsequently decoded into digital electronic form. Data begins at an inner end 9 of the groove and follows the spiral groove outwards. In a conventional single session CD, complying with the "Red Book" standard, the spiral groove contains a session 11 comprising a lead in 12, the audio tracks 14 of the music album, and a lead out 16. The rest of the space 18 available in the spiral groove is commonly empty. CD-ROMS ("Yellow Book" standard) are also single session CDs containing a session 20 comprising a lead in 22, computer-readable data 24 (e.g. directories and files), a lead out 26, and the empty space 28. Multi-session "Blue Book" standard CDs are also known which comprise two session 30, 31 as well as empty space 32. The first session 30 is the Red Book session and the second sessions 31 is the Yellow Book session, as shown in Fig. 5. The Blue Book CD standard is also part of "Orange Book" standard, for recordable CD. Any number of sessions may be recorded in Orange Book and the first does not necessary have to be an audio data session.

Fig. 6 shows a new CD 40 according to one embodiment of the invention. As illustrated in Figs. 6 and 7 this CD contains a first session 42 ("session 1") comprising a lead in 44, digital audio tracks 46, and a lead out 48. Session 1 (42) is conventional Red Book. In addition, the CD 40 contains a second session 50 ("session 2") consisting of a lead in 52, a compressed version 54 of the digital audio tracks 44 in the Red Book session, and a lead out 56. The remaining space 58 on the CD is empty.

On a typical CD Album, around 50 minutes of uncompressed audio data is stored (about 504Mbytes of data). An additional 50 minutes of CD quality MPEG layer 3 compressed audio can be stored easily (approximately 47 Mbytes at 128Kbits/second) in the recording space left on the CD after the uncompressed audio data. Typically, as shown in Fig. 6 the Red Book session 42 comprises 2.77 cm of the full radius of the CD, while the new session 50 would comprise 0.26 cm of the full radius of the CD, with 0.72 cm of the radius, at the outer edge portion of the CD, remaining empty. The maximum album capacity is normally 74 minutes for a standard CD. The compression ratio used will determine the maximum amount of uncompressed data which may be fitted on the disc. For example, using CD quality MPEG Layer 3 (with a compression

ratio of 12:1) for the data compression in the new CD would lower the maximum capacity to approximately 66 minutes. This still equates to about twelve 5½ minute songs, easily enough for the majority of CD albums released, virtually the only exception being commercial compilation CDs which push the running time up to the maximum capacity.

The additional session 50 can be stored immediately after the Red Book Session, in identical fashion to the Blue Book session in multi-session (so called) "CD Extra" standard. Blue Book or "CD Extra" is a multi-session CD format that adds computer-executable interactive multimedia to a normal album. The new session 50 may be created on the CD 40 during a Blue Book style recording and manufacturing process, as shown in Fig. 9, to produce an interactive CD-album with high speed download capabilities. (The typical Blue Book interactive computer data 24 is shown in broken lines in Fig. 9 to emphasise that in fact it is not necessary to always include this interactive component in the CD along with the compressed audio tracks 54, it is merely an option).

In more detail, Fig. 8 illustrates the conventional production process of a Blue Book standard CD, often referred to as multi-session CD, or "CD-Extra". Following the audio mixing and editing in a mixing/editing studio 70, the Red Book

formatting process 73 takes place in a CD production facility 72, to produce the Red Book Session 30 on the CD. Blue Book formatting 74, to produce the Yellow Book Session 31 on the CD, also takes place in the CD production facility 72, using input data obtained in a multimedia production studio 76 in which creation of multimedia software designed to run on a PC (having been read off the CD by a CD-ROM drive) takes place, e.g. incorporating band pictures/videos/lyrics/games.

Fig. 9 illustrates how the conventional Blue Book production process can be modified to produce the new CDs. Like components/blocks to those in Fig. 8 are referenced by like numbers. In this case, a modified Blue Book process 74 is used to produce the second session 50 in the new CD in which the compressed version 54 of the audio data 14 from the Red Book session is stored onto the CD. This modified Blue Book formatting 74 may also include formatting the conventional multimedia interactive computer data component 24 (from the multimedia production studio 76) onto the CD in the same session 50 as the compressed audio. The compressed audio is produced, following the audio mixing and editing studio 70 process, using an audio compression facility 78 provided in the CD production facility 72. It will be appreciated that the audio compression technique, and compression algorithm

used, may be of any of the types which will be generally known to the person skilled in the art.

By designing the CD 40 to be compatible with existing CD standards, then if the compressed audio is stored in its plain format i.e. MPEG Layer 3, as well as being easily downloaded to solid state memory the compressed data could also potentially be quite quickly and easily be downloaded from the CD onto a PC and/or further made available on the internet. The ease with which this could be done may be undesirable to the Music Industry, and so we further propose encrypting the compressed audio tracks 44 (either after, or simultaneously with, the data compression) to make it more difficult to access the compressed audio.

In the illustrated embodiments, lead in 52 of the second session 50 contains information relating to the compression algorithm used to compress the audio data. This information may, if desired, be encrypted, or otherwise protected, so that it can be read and/or recognised only by authorised audio player systems e.g. by a high speed audio dubbing system for use with portable compressed audio players, as described in our pending UK Patent Application No. 9825338.8.

In the embodiment of Figs. 6 and 7, the compressed data 44 is also encrypted and the lead in 52 of the second session 50 also includes details of the encryption algorithm that has been used. The audio data can only be decompressed and read by a solid state audio player that recognises the type of encryption used. The encryption can thus be used to control the copying of data from the CD to another digital storage medium.

One way of effectively encrypting the data is to use a compression format which is non-standard, i.e. a slightly modified version of MPEG. This serves as an encryption method since the data cannot be read easily unless the appropriate decompression method is known. Alternatively, an encryption method based on the Data Encryption Standard (DES), with the key hidden in the Lead-in 52, could be implemented.

Another situation in which the new CD may be produced, in addition to the production at industrial manufacturing/duplication sites, is in networked music distribution where one mode of delivery is through using recordable CD-ROMs. Buyers purchase individual tracks which are then recorded onto CD, labels printed etc. This can be carried out at dedicated stations in shops, or even carried out at home. Buyers could be allowed to create their own

compilations in both the usual CD audio format, and in the new CD format in which for each audio track a compressed version of the same audio track is also stored on the CD, enabling high speed transfer of the compressed version from the CD to audio player systems equipped to decompress the audio.

Download to Audio Player

Fig. 7 illustrates how the new CD/DVD is used to download the compressed audio to an audio player. The compressed audio 54 in the second session 50 is downloaded directly to DRAM or FLASH memory 61 in an Audio player system 60 (via interface hardware 63 in the player 60) using a suitably configured (i.e. with additional software/firmware to read and transfer the compressed audio 54) dubbing unit 65 incorporating a CD reader and an interface for downloading data to the player 60. The speed of the download is determined by the maximum speed of the CD reader, or the maximum write cycle time for the solid state memory 61. Having the compressed version 54 of the audio data available in compressed form for direct download to the solid state memory 61 removes the requirement for mechanical moving parts to be provided in the audio player 60, for reading the CD 40, in contrast to players that directly playback minidisc or compact disc, for example. The dubbing unit 65 may, for example, be a PC with a CD-ROM drive,

programmed with appropriate software/firmware. Alternatively, an "audio dubbing station" as described in our pending UK Patent Application No. 9825338.8 could be programmed/configured to read and download the compressed version 54 of the audio from the CD 40.

The transfer of the compressed audio data 54 can be carried out at high speed, much greater than real time, and may, for example be transferred at greater than 10 times real-time. By way of an example, if the compression algorithm compresses the audio data 46 by a factor of 12 and the download from the CD is carried out at 24 times speed (24 times faster than CD-DA Red Book audio playback rate), the total speed to transfer the compressed digital audio data 54 will be 12 x 24 = 288 times faster than real-time. Thus an audio session (uncompressed) with a real time duration of 60 minutes, can be transferred to the solid state memory in 12.5 seconds (assuming that the data can be written to the solid state memory 61 at an appropriate data rate).

Details of the compression algorithm used can be stored in the lead in 52 of the second session 50, and can be recognised by an audio player system programmed to read and recognise that compression algorithm. A programmable decoder 62 within the audio player 60 can be programmed to decode the type of

algorithm specified in the lead in. In this case the decoder is likely to be a microprocessor, for example a digital signal processor or an advanced RISC machine (ARM) processor with the ability to be re-programmed for different decompression algorithms. The decoder thus decompresses the compressed digital audio and passes it to a D/A converter which converts the audio to analogue from which is played back to a user via headphones 68.

Further to the programmable decompression highlighted above, the lead in 52 may also include data relating to a chosen encryption algorithm. The decoder 62 within the audio player is also programmed to recognise the encryption type as the compressed audio is downloaded, and to decode for both decompression and encryption.

Only audio players that have been programmed (or otherwise configured) to decompress and decrypt the downloaded compressed audio data (according to the particular compression and encryption algorithm which were used during the CD production process) can therefore make use of the compressed audio provided on the original CD 40.

It will be appreciated that various modifications to the above-described embodiment are possible without departing from

the scope of the invention. For example, instead of storing the compressed audio in a separate session on the CD it could be stored as a separate "track" in the Red Book session on the CD.

The solid state memory to which the compressed audio is downloaded could be a removable FLASH memory card for insertion in a PC, audio dubbing unit or solid state audio player system.

It will also be appreciated that the present invention is applicable not only for conventional audio CDs, but for other optical disc formats too e.g. DVD, CD-Recordable and CD-ReRecordable formats. In each case the new disc would contain a set of audio data for playback in a CD player system, and a second set of data comprising a compressed version of the same audio data.

CLAIMS

1. An optical storage disc having stored thereon a first set of data comprising audio data for playback by an optical storage disc player system, and a second set of data comprising a compressed version of said audio data.

2. An optical storage disc according to claim 1, wherein said disc is a Compact Disc (CD).

3. An optical storage disc according to claim 1, wherein said disc is a Digital Video Disc (DVD).

4. An optical storage disc according to any preceding claim, wherein the audio data in said first set of data comprises an album of music tracks, whereby said second set of data comprises a compressed version of the whole album.

5. An optical storage disc according to any preceding claim, wherein the disc comprises a first session consisting of a first lead in, said first set of data and a first lead out, and a second session consisting of a second lead in, said second set of data, and a second lead out.

6. An optical storage disc according to claim 5, having additional data stored thereon.

7. An optical storage disc according to claim 6, wherein said additional data comprises computer-executable interactive multimedia data.

8. An optical storage disc according to any of claims 1 to 4, wherein disc is a single session disc where said first set of data is stored thereon as a number of audio tracks in a single session and said second set of data is stored as an additional track in the session, the session further including a lead in and a lead out.

9. An optical storage disc according to any preceding claim, wherein details of a compression algorithm used to compress the audio data are also stored on the optical storage disc.

10. An optical storage disc according to claim 9, wherein said details of the compression algorithm are stored in a lead in of a session which contains said second set of data.

11. An optical storage disc according to any preceding claim, wherein the compressed data of the second set of data stored in the optical storage disc is encrypted.

12. An optical storage disc according to claim 11, wherein a lead in of a session of the disc which contains the encrypted data includes details of the encryption algorithm used to encrypt the data.

13. An optical storage disc according to any preceding claim, wherein said second set of data is in MPEG Layer 3 compression format.

14. A method of storing audio data on an optical storage disc, the method comprising storing on the disc a first set of data comprising audio data for playback in an optical storage disc player system, and further storing on the disc a second set of data comprising a compressed version of said audio data.

15. An optical storage disc substantially as described herein and as shown in Fig.6.

-20-

Application No: GB 9827717.1 **Examiner:** Rebecca Villis
Claims searched: 1-15 **Date of search:** 12 April 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): G5R (RAC), (RAD), (RGA), (RB24D), (RB27), (RB885)

Int Cl (Ed.7): G11B 7/007, 7/013, 20/00

Other: Online: EPODOC, WPI, PAJ

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0777227 A1	(SONY) (see abstract and col.3 lines 15-53 and claim 5)	1-8,10-15
X	US 5619731	(ARDENT TELEPRODUCTIONS) (see abstract and col. 4 lines 7-20)	1-8, 10-15

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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